



# **TENNESSEE BUREAU OF INVESTIGATION**

## *Forensic Services Division*

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### **Firearms/Toolmarks Standard Operating Procedures Manual**

#### **Microscopic Comparison Procedure**

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## **16.0 MICROSCOPIC COMPARISON PROCEDURE**

A comparative examination is a physical test performed on two or more items for the purpose of determining whether or not an association between the items exists. The basis for identification is founded on the principle that all objects are unique to themselves and can be differentiated from one another. The underlying mechanism for the origination of toolmarks is that when a harder object (the tool) comes in contact with a softer object (work piece), the harder object will impart its marks on the softer object. The surfaces of a tool contain random, microscopic irregularities that are produced during the tool's manufacture and/or through wear, use, and/or abuse. These irregularities which are formed randomly, are considered unique and can individualize or distinguish one tool from another. Because these irregularities or individual characteristics are typically imparted onto the work piece, the comparative examination of the imparted markings allow the tool to be individually associated or identified as having produced the toolmark. The significance of these associations (identifications) are made to the practical, not absolute, exclusion of all other firearms/tools.

**16.1 Scope:** In order for a firearm examiner to associate an item of fired evidence back to the firearm that produced it, or a tool to a particular toolmark, a comparative examination utilizing a comparison microscope shall be performed. The comparison microscope allows the examiner to place two objects on the microscope stages for side-by-side comparative examinations. This process begins with a study of the most general characteristics (class) of items to be compared, progressing through (subclass) to the analysis and comparison to the most specific characteristics (individual). This procedure may also be used to compare two unknown pieces of fired evidence, or unknown toolmarks, together to determine if they were made by the same firearm or tool.

**16.2 Precautions/Limitations:** Not Applicable.

### **16.3 Related Information:**

**16.3.1** Range of Conclusions Appendix 4

**16.3.2** Performance Checks and Maintenance Appendix 7

**16.3.3** Verifications and Casework Review Appendix 8

### **16.4 Instruments:**

**16.4.1** Comparison Microscope

**16.4.2** Stereomicroscope

**16.5. Reagents/Materials:** None

### **16.6 Hazards/Safety:**

**16.6.1** It is the responsibility of the firearm examiner to employ appropriate safety and health practices at all times.

### **16.7 Reference Materials/Controls/Calibration Checks:**



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**16.7.1** All maintenance and calibration checks shall be performed in strict accordance to those listed in Appendix 7 – Performance Checks and Maintenance.

#### **16.8 Procedures/Instructions:**

Prior to any microscopic comparisons, each individual piece of evidence must be evaluated for suitability. This may be accomplished by utilizing the comparison microscope or a stereoscope, and will be documented in the case record.

##### **16.8.1 Firearm Related Evidence**

- Select the correct objective (magnification) setting and ensure that the objectives are locked in place.
- The illumination must be properly selected and adjusted. Oblique lighting is usually preferred. Available lighting sources include halogen, fluorescent, LED, and fiber optic. It is the examiner's discretion to choose the best illumination type for visualizing individual characteristics.
- If a firearm is included as part of the case, compare the tests produced from the firearm to establish reproducibility of individual characteristics produced by the firearm on the test cartridge cases and bullets (mechanical fingerprint). Index marks may be placed on test bullets at this point.
- Once the individual characteristics are determined, the firearm examiner will compare the evidence fired bullets and cartridge cases to the tests produced by the firearm. This will be done by placing the test fired bullet or cartridge case on one stage of the comparison microscope, and the evidence bullet or cartridge case on the other stage. This process will be repeated until all evidence bullets and cartridge cases have been examined.
- If a firearm is not submitted, the same systematic approach should be taken. Two pieces of evidence should be compared side-by-side for similar matching individual characteristics, then substituting other pieces of evidence and looking for similar matching individual characteristics. This should be done until all pieces of evidence are examined.
- If an identification is not initially made, the firearm examiner should consider the following factors:
  - Angle of lighting.
  - Type of lighting.
  - Changing magnification.
  - The type of ammunition submitted or test fired.
  - The need for additional test fires.
  - The position of the evidence, the tests or both.



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- The possibility of cleaning the firearm, then firing additional tests.
- The possibility that the firearm itself has changed.
- Note: Comparative microscopic examinations are not required when the class characteristics are different.

#### **16.8.2. Toolmark Related Evidence**

- Select the correct objective (magnification) setting and ensure that the objectives are locked in place.
- The illumination must be properly selected and adjusted. Oblique lighting is usually preferred. Available lighting sources include halogen, fluorescent, LED, and fiber optic. It is the examiner's discretion to choose the best illumination type for visualizing individual characteristics.
- If a tool is included with the case, compare the test toolmarks produced from the tool to establish reproducibility of individual characteristics produced by the tool (mechanical fingerprint). Index marks may be placed on tests at this point.
- Once the individual characteristics are determined, the firearm examiner will compare the evidence toolmarks to the tests produced by the tool. This will be done by placing the test toolmarks on one stage of the comparison microscope, and the evidence toolmarks on the other stage.
- If a tool is not submitted, the same systematic approach should be taken. Two pieces of evidence should be compared side-by-side for similar matching individual characteristics, then substituting other pieces of evidence and looking for similar matching individual characteristics. This should be done until all pieces of evidence are examined.
- If an identification is not initially made, the firearm examiner should consider the following factors:
  - Angle of lighting.
  - Type of lighting.
  - Changing magnification.
  - The substrate used to produce test toolmarks.
  - The need for additional tests.
  - The position of the evidence, the tests or both.
  - The possibility of varying the angle of force used and creating additional tests.
  - The possibility that the tool itself has changed.
  - The possibility that the tool was used incorrectly, atypically, in a non-conventional manner, or in any manner not intended by the manufacturer.
- Note: Comparative microscopic examinations are not required when the class



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characteristics are different.

**16.9 Records:** The firearm examiner shall document their findings in the form of handwritten or computer generated notes. If possible, the firearm examiner should photographically document the microscopic observations made. The condition of the evidence and the availability of equipment may make this impractical. All identifications require two forms of documentation (drawings, narratives or descriptive information, or photography). The firearm examiner shall strictly adhere to all note taking procedures as prescribed by laboratory policy.

#### **16.10 Interpretations of Results:**

The Association of Firearm and Tool Mark Examiners (AFTE) has set forth a Theory of Identification.

**16.10.1 IDENTIFICATION:** The AFTE Theory of Identification enables opinions of common origin to be made when the unique surface contours of two toolmarks are in “sufficient agreement.”

This “sufficient agreement” is related to the significant duplication of random toolmarks as evidenced by the correspondence of a pattern or combination of patterns of surface contours. Significance is determined by the comparative examination of two or more sets of surface contour patterns comprised of individual peaks, ridges and furrows. Specifically, the relative height or depth, width, curvature and spatial relationship of the individual peaks, ridges and furrows within one set of surface contours are defined and compared to the corresponding features in the second set of surface contours. Agreement is significant when it exceeds the best agreement demonstrated between toolmarks known to have been produced by different tools and is consistent with agreement demonstrated by toolmarks known to have been produced by the same tool. The statement that “sufficient agreement” exists between two toolmarks means that the agreement is of a quantity and quality that the likelihood another tool could have made the mark is so remote as to be considered a practical impossibility.

- Currently the interpretation of individualization/identification is subjective in nature, founded on scientific principles and based on the examiner’s training and experience.

#### **16.10.2 INCONCLUSIVE**

- Some agreement of individual characteristics and all discernible class characteristics, but insufficient for an identification.
- Agreement of all discernible class characteristics without agreement or disagreement of individual characteristics due to an absence, insufficiency, or lack of reproducibility.
- Agreement of all discernible class characteristics and disagreement of individual characteristics, but insufficient for an elimination.

**16.10.3 ELIMINATION:** Significant disagreement of discernible class characteristics and/or individual characteristics.



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**16.10.4 UNSUITABLE:** Unsuitable for microscopic examination.

**16.11. Report Writing:** Most microscopic comparison report writing can be found in the Range of Conclusions Appendix 4.

**16.12. References:**

Association of Firearm and Tool Mark Examiners Training Manual, March 3, 2001

Association of Firearm and Tool Mark Examiners Procedures Manual, July 9, 2001

Association of Firearm and Tool Mark Examiners Glossary, 5<sup>th</sup> Edition, 2007

Association of Firearm and Tool Mark Examiners SWGGUN Admissibility Resource Kit (ARK)

Biasotti, A. A., "Methods Applied to the Comparison of Class and Individual Characteristics in Firearms and Toolmark Identification", AFTE Journal, April 1989, Vol. 21, No. 2, pgs. 260-263.